Committee on Earth Observation Satellites
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CEOS/17/SFCG

Item 18

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REPORT OF THE SPACE FREQUENCY COORDINATION GROUP (SFCG)

SUMMARY AND PURPOSE

This paper provides a report on the efforts of the SFCG, including:

- Results of 2003 World Radiocommunication Conference (WRC-03)
- WRC-07 SFCG Objectives
- Issues related to Ultra Wide Band devices
- Contribution expected from CEOS

ACTION PROPOSED

SFCG proposes the following actions to CEOS agencies:

1. Agencies to begin lobbying within their administrations for supporting studies within the ITU for developing appropriate sharing criteria of passive sensor allocations in 10.6-10.68 and 36-37 GHz bands (WRC-07 Agenda Item 1.2)
2. Agencies to begin lobbying within their administrations for supporting studies within the ITU for expansion by 100 MHz the present geostationary meteorological satellite allocation in 18.1-18.3 GHz (WRC-07 Agenda Item 1.2)
3. Agencies to begin lobbying within their administrations for supporting studies within the ITU for expansion by 200 MHz the active sensor allocation at 9500-9800 MHz (WRC-07 Agenda Item 1.3)
4. Agencies to begin lobbying within their administrations for supporting studies within the ITU for protection of the passive sensor allocations in 1.4-1.427, 23.6-24, 31.3-31.5, and 50.2-50.4 GHz from unwanted emissions from active services in adjacent or nearby bands (WRC-07 Agenda Item 1.20)
5. Agencies to be made aware of the importance of protecting the purely passive sensing bands from UWB devices, particularly in 23.6-24 GHz
6. CEOS Chairman to arrange for SFCG to be provided with a document indicating the perceived priorities in the mid- and long-term for frequency bands to be used for passive and active sensing. The proposed deadline is August 19, 2004, in order to have the document available at SFCG-24 (mid-September 2004). Please note that this is a re-iteration of a request made last year.

Results of WRC 2003

WRC 2003 achieved results in close conformity with SFCG goals.

Since the conclusion of the World Radiocommunication Conference (WRC 2003) held in Geneva, Switzerland, from June 9 to July 4, 2003, under the auspices of the International Telecommunication Union (ITU), the world space science community has gained access to seven new or improved frequency allocations, three of which involve the Earth exploration satellite service (EESS).

The space science requirements and the technical foundations upon which the new allocations were based had been established in the technical groups of the ITU during the period since the previous conference, Istanbul, 2000. The space agencies of the world also worked to refine the technical and operational requirements within the Space Frequency Coordination Group (SFCG). This group, worked diligently to acquaint the ITU member countries and the regional groupings with the requirements of the space science community, and the possible methods that could be used to share the needed frequency bands between both space science radio systems and other space and terrestrial radio systems either already using the frequency bands mentioned or soon to be introduced in those bands.

The usefulness of the results to space science community can be seen from this brief summary of those three accomplishments pertaining to the EESS:

1. The United Nations Conference on the Environment and Development held in Brazil in 1992 clearly identified an urgent requirement for radar systems operating from space platforms to be able to sense the environment in a frequency band that could “see through” the canopy of forests around the world to assist in tracking the migration of herds of wild animals. Such a frequency band can only be found in the range from 300 to 600 MHz, and WRC 2003 deemed fit to allocate, albeit on a secondary basis, the range from 432 – 438 MHz to the earth exploration-satellite service (EESS) to conduct such observations. Considering that this frequency band is already used by a number of terrestrial systems, complex protections had to be devised to prevent the space science radars from causing harmful interference to current users. The willingness of the SFCG members to facilitate operational coordination with existing systems was crucial in enabling the allocation to be made. Additionally, the SFCG’s offer to post mission information and ephemeris data on its web site for such SAR missions in the 432 - 438 MHz band was accepted by WRC-03 and was instrumental in obtaining the allocation.

2. For some years the EESS has enjoyed access to the frequency band from 5250 – 5460 MHz to conduct active radar observations. Successful missions, such as RADARSAT, use synthetic aperture radar imaging systems operating in this frequency band to monitor environmental change and support resource sustainability. During preparations for the WRC 2000, the need to extend that allocation up to 5570 MHz was identified, in order to improve the resolution of the delivered images to better than 1 meter. WRC 2003 made the new allocation and identified appropriate mechanisms to protect existing terrestrial systems.

3. WRC 2003 removed the very restrictive footnote 5.551A from the frequency band allocated to the EESS (active) from 35.5 – 36.0 GHz. A new footnote was adopted providing for power flux density limits at the surface of the Earth on transmissions from the EESS, but this new footnote improves the sharing conditions among the services allocated.

It should be noted that the first issue has been around, unresolved, since WRC 1995. To have cleared it from the agenda for the next WRC at a time when ITU-R is looking for ways of cutting the budget is very timely.

SFCG WRC-07 Objectives

Introduction

These are the objectives of SFCG members relative to the space science services on the agenda of the 2007 World Radio Communication Conference (WRC-07). The contents may be used not only by SFCG members, but also by the CEOS membership, to inform their administrations and to facilitate conference preparation and WRC consideration.

The presentation is organized to align with agenda for the WRC-07 as presented in Resolution 802 (WRC-03). Since only some of the items in that agenda are of interest to the SFCG and to the CEOS membership, only those specific agenda items relating to Earth exploration satellite sensors are discussed herein.

SFCG promotes the use of space-based passive sensors to provide vital ecological and environmental data that is unobtainable by any other means. Such passive sensors depend for their successful operation on frequency bands that are defined by the physical laws of the atmosphere.

However, in frequency bands allocated to the Earth exploration-satellite (passive) service, where sharing with active systems has been shown to be not feasible, the SFCG holds the view that such active systems should not be implemented, and would support any review by administrations that might lead to a reduction in the number of such infeasible sharing situations in the Table of Frequency Allocations.

Agenda Item 1.2 "to consider allocations and regulatory issues related to the Earth exploration-satellite (passive) service, space research (passive) service and the meteorological satellite service in accordance with Resolutions 746 (WRC-03) and 742 (WRC-03)"

Resolution 746 calls for sharing analyses between geostationary meteorological satellites operating in the space-to-Earth direction and the fixed, fixed-satellite and mobile services in the band 18-18.4 GHz to define appropriate sharing criteria with a view to extending the current 18.1-18.3 GHz geostationary meteorological satellites allocation in the space-to-Earth direction to 300 MHz of contiguous spectrum. This will satisfy the requirement for the transmission of data from high-resolution sensors on the next generation geostationary meteorological satellites, which will be launched in the 2015-2020 time frame. SFCG supports this expansion of the current 18 GHz allocation for transmission of high rate data from geostationary meteorological satellites. SFCG members are encouraged to support these studies and their discussions within SFCG and via contributions to and participation in ITU-R Working Party 7B.

Resolution 746 calls for sharing analyses between the EESS (passive) and the SRS (passive) and the fixed and mobile services in the band 10.6-10.68 GHz to determine appropriate sharing criteria. The EESS (passive) operating in the band 10.6-10.68 GHz may experience harmful interference from the emissions of systems of active services. The band 10.6-10.68 GHz is of primary interest for the measurement of

rain, snow, sea state, ocean wind and soil moisture. SFCG supports the protection of the passive services from the active services in the 10.6-10.68 GHz band. SFCG members are encouraged to support these studies and their discussions within SFCG and via contributions to and participation in ITU-R Working Party 7C.

Resolution 742 calls for sharing studies between the passive services and the fixed and mobile services in the band 36-37 GHz in order to define appropriate sharing criteria. EESS (passive) systems may experience harmful interference if a high density of fixed or mobile service stations is deployed in the band 36-37 GHz. SFCG supports the protection of EESS (passive) systems and encourages its members to carefully consider any deployment of fixed or mobile service stations in the 36-37 GHz band within their Administrations. Information to support sharing studies in the 36-37 GHz band was called for in SFCG Action Item 22/8.

Agenda Item 1.3 "in accordance with Resolution 747 (WRC-03), consider upgrading the radiolocation service to primary allocation status in the bands 9 000-9 200 MHz and 9 300-9 500 MHz and extending by up to 200 MHz the existing primary allocations to the Earth exploration-satellite service (active) and the space research service (active) in the band 9 500-9 800 MHz without placing undue constraint on the services to which the bands are allocated"

Resolution 747 calls for the technical characteristics, protection criteria, and other factors of radiolocation, radionavigation, EESS (active) and space research (active) systems that ensure compatible operations in the band 9 300-9 500 MHz and the study of the compatibility between terrestrial radars of the radiolocation and radionavigation services, and spaceborne radars of the Earth exploration-satellite and space research services in the band 9 3009 500 MHz. In the event that sharing studies in the 9 300-9 500 MHz band lead to unsatisfactory conclusions which do not fully satisfy the requirement for an increase by up to 200 MHz of contiguous spectrum for EESS (active) and space research (active) services, additional sharing studies in the alternative frequency range 9 800-10 000 MHz are to be performed. SFCG Action Item 22/6 called for the characteristics of active sensors, justification for the expanded bandwidth, and the feasibility of sharing studies in either the 9 300-9 500 MHz band or the 9 800-10 000 MHz band. SFCG supports the increase in the current 9 GHz allocation to the EES (active) and SRS (active).

Agenda Item 1.8 "to consider the results of ITU-R studies on technical sharing and regulatory provisions for the application of high altitude platform stations operating in the bands 27.5-28.35 GHz and 31-31.3 GHz in response to Resolution 145 (WRC-03), and for high altitude platform stations operating in the bands 47.2-47.5 GHz and 47.9-48.2 GHz in response to Resolution 122 (Rev.WRC-03)"

Resolution 145 (WRC-2003) calls for technical sharing criteria for high altitude platform stations (HAPS) system design conditions to ensure that HAPS applications in the fixed service operate successfully on a non-harmful interference, non-protected basis in the bands 27.5-28.35 GHz and 31-31.3 GHz. The 31.3-31.8 GHz band is allocated to the radio astronomy, Earth exploration-satellite (passive) and space research (passive) services. WRC-03 amended No. 5.543A to specify signal levels that would protect satellite passive services and radio astronomy stations in the band 31.3-31.8 GHz.

According to Recommendation ITU-R SM.1633, the EESS (passive) in the band 31.3-31.5 GHz can be protected if the unwanted emissions of fixed-service systems (except HAPS) operating in the band 31.0-31.3 GHz do not exceed – 38 dBW in a 100 MHz reference bandwidth in the band 31.3-31.5 GHz. However, the results of Rec. ITU-R SM.1633 were based on the use of values obtained from Rec. ITU-R SA.1029-1, which have been superseded by Rec. ITU-R SA.1029-2. This will require revision of annexes found in Rec. ITU-R SM.1633 pertaining to EESS and re-examination of the corresponding results.

SFCG supports the need for protection of the 31.3-31.8 GHz allocation to the radio astronomy, Earth exploration-satellite (passive) and space research (passive) services. SFCG members will review the results of the HAPS studies as documented by Working Party 4-9S, and participate in Working Parties 7C, 7D and 4-9S as necessary to ensure that the passive space science services are protected.

Agenda item 1.17 "to consider the results of ITU-R studies on compatibility between the fixed-satellite service and other services around 1.4 GHz, in accordance with Resolution 745 (WRC-03)"

Resolution 745 (WRC-03) calls for studies, including the measurement of emissions from equipment that would be employed in operational systems, to validate that the systems meet all requirements for the protection of passive services in the band 1 400-1 427 MHz from unwanted emissions from fixed-satellite service (FSS) feeder links for non-geotationary satellite orbit (non-GSO) systems in the MSS with service links operating below 1 GHz, and to study the power flux-density (pfd) values required to protect sensors of the EESS (passive) operating in the band 1 400-1 427 MHz. SFCG supports the protection of the passive services in the band 1400-1427 MHz.

Agenda item 1.18 "to review pfd limits in the band 17.7-19.7 GHz for satellite systems using highly inclined orbits, in accordance with Resolution 141 (WRC-03)"

Resolution 141 (WRC-03) calls for studies to determine whether the current pfd limits for non-GSO systems in the FSS in Article 21 are adequate to protect the fixed service in the 17.7-19.7 GHz band from non-geostationary systems without unduly constraining the use of these non-GSO FSS systems, and to determine whether there are technical and operational measures in the band 17.7-19.7 GHz that could be implemented in the fixed service to mitigate interference from FSS space stations. The band 18.1-18.3 GHz is allocated to the meteorological-satellite service (space-to-Earth) on a primary basis, limited to geostationary satellites and in accordance with the provisions of Article 21, Table 21-4, under footnote 5.519. The band 18.6-18.8 MHz is allocated to EESS (passive) and SRS (passive). SFCG supports the protection of these existing science service allocations.

Agenda item 1.20 "to consider the results of studies, and proposals for regulatory measures regarding the protection of the Earth exploration-satellite service (passive) from unwanted emissions of active services in accordance with Resolution 738 (WRC-03)"

Resolution 738 (WRC-03) calls for studies on the compatibility analyses between EESS (passive) and the corresponding active services in certain bands listed below with a view to updating Recommendation ITU-R SM.1633 or developing additional Recommendations.

EESS (passive) band	Active service band	Active service
1 400-1 427 MHz	1 350-1 400 MHz	Fixed service (FS) Mobile service (MS) Radiolocation service
1 400-1 427 MHz	1 427-1 429 MHz	FS, MS (except aeronautical mobile service) and space research service (Earth-to-space)
1 400-1 427 MHz	1 429-1 452 MHz	FS and MS
23.6-24 GHz	22.55-23.55 GHz	Inter-satellite service
31.3-31.5 GHz	30-31 GHz	FSS (Earth-to-space)
50.2-50.4 GHz[1]	50.4-51.4 GHz[1]	FSS (Earth-to-space)[1]
50.2-50.4 GHz[1]	47.2 -50.2 GHz (Regions 2 and 3) 49.44-50.2 GHz[1] (Region 1)	FSS[1]

[1]Studies in this band must take into account No. 5.340.1 of the Radio Regulations which states "The allocation to the earth exploration-satellite service (passive) and the space research service (passive) in the band 50.2-50.4 GHz should not impose undue constraints on the use of the adjacent bands by the primary allocated services in those bands.

According to Recommendation ITU-R SM.1633, the EESS (passive) in the band 52.6-54.25 GHz can be protected if the unwanted emissions of fixed-service systems operating in the band 51.4-52.6 GHz do not exceed –33 dBW in a 100 MHz reference bandwidth in the band 52.6-54.25 GHz. As previously mentioned under agenda item 1.8, the results of Rec. ITU-R SM.1633 were based on the use of values obtained from Rec. ITU-R SA.1029-1, which have been superseded by Rec. ITU-R SA.1029-2. This will require revision of annexes found in Rec. ITU-R SM.1633 pertaining to EESS and re-examination of the corresponding results.

Agenda items not completed at a particular WRC are now given only one additional chance for resolution. Agenda item 1.20 is a carry over from WRC-03 and thus must be completed at the next WRC. The unfinished studies from WRC-03 are arduous and will likely require the entire 4-year cycle to finalize. This is the last opportunity to obtain proper protection of fundamental meteorological passive bands from unregulated unwanted emissions. At risk are three of the key vertical sounder frequencies (23.8 GHz, 31.4 GHz, and 50.3 GHz) used today operationally (e.g. by AMSU-A) as well as planned for future use (e.g. by ATMS and CMIS). Top management from the CEOS space agencies must be willing and able to fund their frequency management offices to perform the necessary technical studies and to participate at regional and ITU level frequency meetings. Without such support it will not be possible to prevail in the battle against strongly backed commercial interests.

Issues Related to Ultra Wide Band Devices

The paramount concern of the SFCG with regard to the implementation of Ultra Wideband (UWB) devices continues to be car radars (or vehicular radars, in more general terminology) operating in the exclusively passive frequency band from 23.6-24 GHz. In 2002 the United States' Federal Communication Commission (FCC) authorized car radars for use of the band from 22 to 29 GHz, even though such use violates the International Telecommunication Union's (ITU's) regulations that prohibit emissions in the band 23.6-24 GHz (Radio Regulation 5.340 states "All emissions are prohibited in the following bands: ….23.6-24 GHz….."). Recently, various organizations and groups have taken exception to the FCC's disregard to the ITU radio regulations and filed statements with the FCC indicating such concern. (Two such statements related to further expansion of the FCC's existing Part 15 rules (Part 15 rules pertain to unlicensed devices such as garage door openers and microwave ovens) for UWB use in the 24 GHz region are found in the attached annex.)

In Europe rules permitting such use are not yet established due to an extensive battle being waged by organizations such as the European Space Agency, EUMETSAT, and the World Meteorological Organization against the main car radar lobbying group known as SARA. The European support of "no emissions" in the 23.6-24 GHz passive sensor allocation remains strong. There is a European movement to consider the 76-77 GHz band in place of the lower frequency. In fact, at least two Japanese automobile manufacturers are already developing such radars at this higher frequency. In Europe the approach is to permit limited use of 24 GHz car radars until such time that systems can be developed at 76-77 GHz. It is hoped that this transition will take place before many systems are deployed using the lower frequency. It is the density (number of cars per km^2) of these systems that causes concern, since Earth resources satellites sensor pixels often cover areas exceeding 100 km^2. A sufficiently high density would produce an aggregate energy level directed skyward toward an Earth exploration satellite capable of causing harmful interference to passive sensors operating in 23.6-24 GHz.

Even though the United States permits the use of 24 GHz for vehicular radars, previously the FCC changed its Part 15 rules to accommodate the use of vehicular radars in 76-77 GHz as well. Such use was re-affirmed in a recent (April 2003) "Notice of Proposed Rule Making" issued by the FCC that states:

> We (i.e. FCC) also note that in 1995, the 76-77 GHz band was made available for use by vehicle radar systems on an unlicensed basis under Part 15 of our Rules. This action received significant industry support in an effort to develop collision avoidance radars for vehicles. The Commission found that the 76-77 GHz band was ideal for unlicensed collision avoidance radars because: 1) the propagation characteristics would reduce the probability of interference between vehicle radar units; 2) this band would reduce manufacturing costs; and 3) the band provided sufficient spectrum needed for tracking edges of roads and proper operation.

Thus there is widespread support for use of the 76-77 GHz band for vehicular radars. The CEOS membership should strongly advocate within their administrations and region telecommunication groups the use of this higher frequency for car radars in lieu of risking future harmful interference to the 23.6-24 GHz band that is vital for monitoring the atmosphere of the Earth.

Contribution expected from CEOS

At its 23rd meeting in September 2003, the SFCG membership considered the preliminary agenda for the WRC-10 as found in ITU Resolution 803 (WRC-03). Not all of the items in that agenda are of interest to the SFCG. However item 2.2 "to consider frequency allocations between 275 GHz and 3 000 GHz taking into account the result of ITU-R studies in accordance with Resolution 950 (WRC-03)" is one of interest not only to the SFCG but should also be to the CEOS Plenary as well. It provides the opportunity for CEOS to have the future planned CEOS sensor frequency needs considered for placement in the ITU's Table of Frequency Allocations. Such needs can be realized by having the SFCG act as the advocate for CEOS and have such frequencies added to the SFCG's list of WRC objectives. **It is incumbent on the CEOS Plenary and its members to take advantage of such an opportunity and provide to the SFCG the necessary input document for consideration at the 24th SFCG meeting in September 2004.** The SFCG web master must receive the contribution electronically no later than August 19, 2004. The email address is: john.e.zuzek@nasa.gov.

ANNEX

STATEMENTS FROM

NATIONAL ACADEMY OF SCIENCES' COMMITTEE ON RADIO FREQUENCIES

AND

NORTHRUP GRUMMAN AND RAYTHEON

REGARDING POTENTIAL INTERFERENCE

TO

PASSIVE SENSORS OPERATING IN 23.6-24 GHz

FROM

VEHICULAR RADARS

Before the

FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's Rules	)	ET Docket No. 98-153
Regarding Ultra-Wideband Transmission Systems	)	

COMMENTS OF THE
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (hereinafter, CORF), hereby submits its comments in response to the Commission's March 12, 2003, Further Notice of Proposed Rulemaking (FNPRM) in the above-captioned docket. In these Comments, CORF opposes the proposal to amend Part 15 rules regarding ultra-wideband (UWB) transmission systems to permit frequency-hopping systems in the 22-29 GHz band. Such systems would pose a significant threat of interference to remote sensing instruments, and thus to the important data being gathered by such instruments.

I. Introduction: The Importance of Remote Sensing, and EESS Observations in the 22-24 GHz Band.

CORF has a substantial interest in this proceeding, as it represents the interests of the passive scientific users of the radio spectrum, including users of the Earth Exploration Satellite Service (EESS) bands. EESS observers perform research that is extremely important yet vulnerable to in-band and out-of-band interference.

As the Commission has long recognized, remote sensing, which includes research done by users of the EESS, is a critical and unique resource for monitoring the global atmospheric and surface state. Satellite-based microwave remote sensing represents the only practical method of obtaining uniform-quality atmospheric and surface data encompassing the most remote oceans as well as densely populated areas of Earth. EESS data have contributed substantially to the study of meteorology, atmospheric chemistry, oceanography, and global climate change. Currently, instruments operating in the EESS bands provide regular and reliable quantitative atmospheric, oceanic, and land measurements to support an extensive variety of scientific, commercial, and government (civil and military) data users. Major governmental users of the EESS data include the National Oceanic and

Atmospheric Administration (NOAA), the National Science Foundation, the National Aeronautics and Space Administration (NASA), and the Department of Defense (especially the U.S. Navy). Applications of the data include aviation forecasts, hurricane and severe storm warning and tracking, seasonal and interannual climate forecasts, decadal-scale monitoring of climate variability, medium-range forecasting, and studies of the ocean surface and internal structure, as well as many others.

Of particular concern to CORF in this proceeding are EESS observations at 22-24 GHz. The 23.6-24.0 GHz band is allocated to passive scientific observers, including EESS and the Radio Astronomy Service. The 22.21-22.5 GHz band is allocated on a co-primary basis to passive scientific users including EESS, as well as to the Fixed and Mobile (except aeronautical mobile) Services. For remote sensing science, these bands reflect the existence of nearby water vapor absorption lines, and observations in these bands are important for measurements of atmospheric humidity (total integrated water vapor).

One of the most important components of Earth's atmosphere, water is essential for human existence. The global water cycle is a key to Earth's climate system, and accurate predictions of the cycle are necessary for monitoring climate variability and change, weather forecasting, and sustainable development of water resources. Such data are critical for making predictions of regional drought or flooding.

Several U.S. satellites currently make observations in these bands. As noted in the FNPRM, these include the Advanced Microwave Scanning Radiometer (AMSR) and the AMSR-EOS (AMSR-E). In addition, the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) operates aboard a NASA satellite. At least three more U.S.-sponsored spaceborne sensors are planned that will observe in these bands:

> --The Advanced Technology Microwave Sounder (ATMS) is currently being developed by NASA for the next-generation polar-orbiting weather satellite, called the National Polar Orbiting Operational Environmental Satellite System (NPOESS). The ATMS system is now being constructed and is scheduled to be in orbit by approximately 2007-2008.
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> --The Conical Scanning Microwave Imager and Sounder (CMIS) will also orbit aboard the NPOESS. This instrument will collect global microwave radiometry sounding data, including atmospheric temperature and moisture profiles, and data on clouds and sea-surface winds. CMIS is now in the engineering design stage and is scheduled to be in orbit by approximately 2008. CMIS is funded by the Integrated Program Office, which is

staffed by personnel from the Department of Defense, the Department of Commerce/NOAA, and NASA.

--The Global Precipitation Measurement Microwave Imager (GMI) is a joint project of NASA and the National Space Development Agency of Japan. A follow-up to the TRMM instrument, GMI is designed to improve ongoing efforts to predict climate by making near-global measurements of precipitation, its distribution, and physical processes; and to improve the accuracy of weather and precipitation forecasts by more accurately measuring rain rates and latent heating. Launch of this instrument is scheduled for 2007.

These new instruments will provide important data on atmospheric moisture and temperature, sea-surface water temperature and wind speed, snow cover, and soil moisture for two to three decades to come. It is essential to protect the ability of the current instruments, as well as those coming online, to take these critical measurements.

II. CORF Opposes Amending the Commission Rules to Permit Frequency-Hopping UWB Systems in the 22-29 GHz Band.

As noted in paragraph 156 of the FNPRM, Siemens VDO Automotive AG (Siemens) has filed a petition seeking an amendment of the Commission's rules that would permit the operation of frequency-hopping UWB systems as vehicular radar systems in the 22-29 GHz band. Under the Siemens proposal, such systems would be permitted to comply with the RMS average emission limits based on measurements averaged over a 10 millisecond (ms) period, rather than on measurements with the frequency hopping stopped. The FNRPM then goes on to note Siemens' claim that the effect of its proposed 10 ms averaging time would be no different from that of non-frequency-hopping UWB devices, "when the integration time of space borne passive sensors is taken into account." But the FNPRM then states that "[Siemens'] claim is not justified . . ." while noting that the AMSR sensor has a 2.6 ms integration time and the AMSU-A sensor [actually the AMSU-A2 module] has integration times of 158-165 ms, and that the integration times of future satellites could vary. *Id*. at para. 157. Lastly, the Commission expresses its concern that devices allowed under the Siemens proposal could generate greater levels of interference than non-frequency-hopping devices, because the extended measurement period could allow frequency-hopping devices to momentarily emit at a much higher level at a particular frequency. *Id.* at para. 159.

CORF shares the Commission's concern. The effect on EESS systems of high-level, low-duty-cycle interference is not the same as that of lower-level, high-duty-cycle interference of the same average transmitted power, unless the averaging time over which the equivalence is established is shorter than

the expected integration time of the EESS measurement. If the averaging time is not shorter than the integration time, then the effective level of interference will grow as the ratio of the averaging time over which equivalence is established to the EESS integration time. EESS integration times are determined by the angular resolution and scan geometry of the sensor. The highest-resolution (and hence shortest integration time) EESS instrument currently operating in the 23.6-24.0 GHz band is the NPOESS CMIS, with an integration time of 1.2 ms.

The 1.2 ms integration time for the CMIS reflects a natural and steady progression beyond last-generation 23.6-24.0 GHz EESS systems, which had integration times on the order of 10 ms. Given the continuing drive in technology toward enhanced angular resolution imagery, it is reasonable to assume that instruments scheduled to go into operation in the next few years will operate with integration times in the range of several tenths of a millisecond. The Siemens proposed averaging time of 10 ms with which to estimate equivalent continuous duty-cycle interference is roughly two orders of magnitude longer than that needed to be consistent with instruments scheduled to go into operation in the next few years. Accordingly, CORF opposes amendment of the Commission's rules to allow frequency-hopping devices at 22-29 GHz. However, if such devices are to be authorized, then CORF suggests that an averaging time of 0.1 ms be used to determine compliance with interference requirements, using the measurement procedure described below.

In para. 161 of the FNPRM, the Commission seeks comments on the measurement procedure for checking compliance of UWB frequency-hopping devices with Commission rules. First, if such devices are to be authorized, then as noted above CORF suggests that the measurement should be done over a 0.1 ms averaging time period, instead of a 10 ms period. Assuming a 0.1 ms averaging time period, the measurement has to answer the question: What is the maximum possible time-averaged level of interference that can be generated over a 0.1 ms interval across the 23.6-24.0 GHz band? Since the source of interference is frequency hopping asynchronously with the 0.1 ms averaging time, it is necessary to take an adequately large number of 0.1 ms samples in order to provide a reliable estimate of the statistical maximum. A swept frequency mode of measurement by a spectrum analyzer is prone to sampling errors if the sweep time, averaging time, and frequency-hopping cycle times are not properly adjusted to prevent under sampling and/or aliasing. A preferred method of measurement would be a fast-response (0.1 ms or faster) power detector measurement with the signal entering the power detector head properly filtered beforehand to define the passband of interest (23.6-24.0 GHz or otherwise). Many measurements (e.g., several seconds at 0.1 ms per sample) should be taken and the maximum value noted. This process should be repeated a number of times to ensure that the estimate of the "maximum" statistic is accurate and repeatable.

III. Conclusion.

For the reasons set forth above, CORF urges the Commission not to amend Part 15 rules regarding ultra-wideband transmission systems to permit frequency-hopping systems in the 22-29 GHz band.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

By: /s/ Bruce Alberts
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July 16, 2003

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Before the FEDERAL COMMUNICATIONS COMMISSION Washington, D.C. 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's	)	ET Docket No. 98-153
Rules Regarding Ultra-Wideband	)	
Transmission Systems	)	

REPLY COMMENTS OF NORTHROP GRUMMAN CORPORATION AND THE RAYTHEON COMPANY

Northrop Grumman Corporation ("Northrop Grumman") and the Raytheon Company ("Raytheon") (collectively, "the Parties"), by counsel, hereby submit these reply comments in response to the Commission's *Further Notice of Proposed Rulemaking* in the above-captioned docket.[1] These reply comments are limited to the Commission's request for comments on proposed additional new rules to address issues raised in the Siemens' petition for reconsideration regarding the operation of frequency-hopping vehicular radars in the 22-29 GHz band as Ultra-Wide Band ("UWB") devices.

The Parties urge the Commission not to permit the operation of pulsed frequency-hopping vehicular short range radar systems near or in the 23.6-24.0 GHz band without adopting strict limits to reduce the potential for increased interference that likely will result under standards being proposed by manufacturers. Additionally, the Parties strongly urge the Commission to clarify existing unlicensed vehicular radar system regulations to limit the sale of Ultra-Wide Band ("UWB") vehicular radar devices to automotive applications using original equipment manufacturer ("OEM") installed units or qualified dealer retrofits to older vehicles where manufacturers can show that the Commission's performance standards can be met.

I. BACKGROUND

The Parties have a substantial interest in this proceeding, as they are now developing the National Polar-orbiting Operational Environmental Satellite System ("NPOESS") under a contract awarded in 2002 by the NPOESS

[1] **Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, *Memorandum Opinion and Order and Further Notice of Proposed Rule Making*, ET Docket No. 98-153, 18 FCC Rcd 3859 (2003).**

Integrated Program Office ("IPO").[2] NPOESS is the nation's next-generation low-earth, polar-orbiting environmental satellite system. Sensors on the NPOESS satellites will use the Earth Exploration Satellite Service ("EESS") bands.

Northrop Grumman is the prime contractor, leading the overall system design effort and space segment, including the development of highly sensitive sensors that sense natural phenomena in the Ka-band. Raytheon is responsible for the ground segment, including command and control, mission data processing, and providing system engineering support. The national investment to build (including options), deploy and operate the NPOESS system from the present through 2018 is projected to exceed $4.5 billion dollars.

Converging NOAA's current Polar-orbiting Operational Environmental Satellite program and DoD's Defense Meteorological Satellite program into a single satellite system, NPOESS will meet critical civilian, homeland and national security requirements for space-based, remotely-sensed environmental data. Through extremely sensitive measurement of propagation in the 23.6-24.0 GHz band, among others, highly detailed modeling of atmospheric, terrestrial and ocean phenomena will allow more precise meteorology as well as the tracking of pollution, environmental change and the impacts of natural or man-made disasters in a manner that will promote public safety, effective defense and economic security. NPOESS satellite sensors will provide higher resolutions and better accuracies than current capabilities, as part of an overall system that will deliver orders of magnitude more data to its users on a much more timely basis. The result will be more accurate short-term forecasts as well as better and more extensive long-term forecasts.

An interference-free environment in the 23.6-24.0 GHz band is critical to the NPOESS system because certain phenomena related to atmospheric and surface conditions only can be observed in and around these frequencies, where water vapor has unique absorption properties. Two specific NPOESS sensor instruments make high sensitivity measurements in this band:

- **Conical Scanning Microwave Imager/Sounder ("CMIS")**. The CMIS collects global microwave radiometry and sounding data to produce microwave imagery and other meteorological and oceanographic data. Data types include atmospheric temperature and moisture profiles, clouds, sea surface winds, and all-weather land/water surfaces. The CMIS detector is critical for short-term

[2] The Departments of Commerce and Defense as well as NASA created the NPOESS Integrated Program Office ("IPO") to develop, acquire, manage, and operate the next generation of polar-orbiting operational environmental satellites.

weather forecasts and critical in responding to short term natural disasters or other catastrophic and/or unseen events. The CMIS contributes to 23 different Environmental Data Records ("EDRs")[3] and is the primary instrument for 9 of these EDRs. Current plans are to deploy the CMIS sensor on all NPOESS satellites.

• **Advanced Technology Microwave Sounder ("ATMS")**.[4] The ATMS instrument is a passive microwave sounder instrument that provides observations which, when combined with observations from an infrared sounder, provides global atmospheric temperature and water vapor profiles. This new instrument will have 22 microwave sounding channels that measure microwave energy emitted and scattered by the atmosphere.

There is no other frequency band in the spectrum with the same characteristics as the 23.6-24.0 GHz band. Total water vapor content from the ground to the satellite is best measured in this band. This is critical to not only measuring atmospheric moisture, but also to separate measurements of surface moisture from atmospheric moisture. Earth surface measurements such as ocean wind speed, surface temperatures, and many surface moisture EDRs rely heavily on total vertical moisture profile derived in this channel. The band also is unique within the microwave spectrum because it covers a small spectral zone where water vapor in the lower levels of the atmosphere is a moderately strong absorber of radiation. Clouds and water vapor have similar spectral patterns of absorption in most of the microwave spectrum, except for the 23.6-24.0 GHz band. This distinction makes this band critical for separating the cloud effects from the water vapor effects. In short, the generation of most CMIS and ATMS EDRs depend on this channel because of these characteristics.

The 23.6-24.0 GHz band is absolutely essential to meeting NPOESS mission requirements. Any man-made emissions (in-band or out-of-band) that are of significant amplitude with respect to the noise levels of the passive receivers will degrade measurement skill for CMIS and ATMS top-priority missions. If such emissions happen broadly or frequently, they would jeopardize the ability of NPOESS to meet its performance requirements.

While the Parties recognize the potential benefits from vehicular radars, they remain quite concerned about the potential for degradation if emission limits

[3] The basic output from NPOESS will be a collection of EDRs. EDRs contain the environmental parameters or imagery required by users for weather prediction and environmental monitoring.

[4] An ATMS instrument will also fly on the NPOESS Preparatory Project (NPP) satellite, which is scheduled to launch several years prior to NPOESS as a bridge to these new capabilities.

into 23.6-24.0 GHz are exceeded or if deployment is different from what had been modeled when the UWB rules were adopted. Protection against harmful interference to remote passive sensors deployed by NPOESS is important not only in view of the billions of dollars of taxpayer and government money to be spent on the NPOESS system, but also because the capabilities of the NPOESS system to offer significant safety of life benefits, support for homeland security and defense objectives. For example, the knowledge obtained from NPOESS data will reduce the potential loss of human life and property resulting from severe weather events or atmospheric conditions coincident with natural or man-made catastrophes. Support for general aviation, agriculture, and maritime activities aimed at improved early warnings will mitigate the devastating effects of floods through disaster planning and response. From a national security perspective, NPOESS shifts the tactical and strategic focus from coping with weather to anticipating and exploiting atmospheric and space environmental conditions. Proposals to amend the Commission's rules to permit pulsed frequency-hopping vehicular radars to be included under the definition of a UWB device must be closely scrutinized to ensure that limits are adopted that prevent potentially disruptive changes to these NPOESS objectives.

II. THE PARTIES SUPPORT THE NATIONAL ACADEMY OF SCIENCES' COMMITTEE ON RADIO FREQUENCIES ("CORF") RECOMMENDED MEASUREMENT INTERVAL AND TECHNIQUES

In its comments, CORF expresses concern that devices allowed under the Siemens proposal could generate greater levels of interference because the emission level measured under an extended measurement period may not be a true average emission but could be more similar to a time averaged emission.[5] In other words, an extended measurement period could allow frequency-hopping devices to momentarily emit at a much higher level at a particular frequency, which would generate increased interference to space borne passive sensors unless the averaging time is shorter then the integration time of the passive measurement. The Parties agree and join CORF's comments in that respect.

The Parties believe that passive radiometer integration time is a key factor in determining interference. To ensure that UWB interference to space borne passive sensors does not exceed the threshold for frequency hopping, the Parties urge the Commission to ensure that the EFPD limits applicable to frequency-hopping devices are met with an integration time that is significantly less than the passive sensor integration time. Otherwise, the limits applicable to the unlicensed devices cannot provide us assurances that there will not be

[5] **See CORF Comments at 5.**

harmful interference to earth exploration sensing devices. As CORF notes,

EESS sensors being developed for the Ka-band have integration times as low as 1.2 milliseconds and these times are likely to decrease as sensor technology improves.[6] Accordingly, the Parties support CORF's recommendation that as a condition of permitting frequency-hopping devices in the 22-29 GHz band, that an averaging time of 0.1 milliseconds be used to determine compliance with interference requirements into 23.6-24.0 GHz, using a fast response (0.1 milliseconds or faster) power detector measurement with the signal entering a power detector head properly filtered to define the passband of interest.[7]

III. PRELIMINARY ANALYSIS INDICATES THE POSSIBILITY OF INCREASED RISK OF INTERFERENCE TO SPACE BORNE PASSIVE SENSING SYSTEMS

When adopting rules in 2002 to permit the unlicensed operation of certain vehicular radar systems in the 22-29 GHz band, the Commission determined that attenuation of emissions below 24.0 GHz is required above the horizontal plane in order to protect space borne passive sensors operating in the 23.6-24.0 GHz band. The specific attenuation requirements are set forth in Section 15.515(c) of the Commission's Rules, 47 C.F.R. § 15.515(c). The rules require the level of attenuation to tighten in three steps beginning with equipment authorized, manufactured, or imported on or after January 1, 2005. The requirements become more stringent on January 1, 2010, and even more exacting on January 1, 2014.

The Parties are continuing their analysis of the potential impact of vehicular radar systems in the Ka-band on CMIS and ATMS sensing operations.[8] However, preliminary findings using the Rec. ITU-R SA 1029-2 limit of -166 dBW/200 MHz as the interference noise density threshold show that cumulative interference from vehicular radar devices to the CMIS and ATMS passive sensing instruments in areas of high vehicle density (*i.e.*, areas of high population density) will approach this interference threshold, even when using the more conservative limits required for equipment authorized, manufactured or imported after *January 1, 2010*. Given that there is very little margin against harmful interference using the 2010 levels, the Parties are concerned that there is considerable potential for interference to space borne passive sensors if radar is deployed in significant numbers of vehicles applying only the pre-2010 standards. Consequently, it is all the more important that very strict standards apply to any additional types of vehicular

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[6] ***Id.*** **at 6.**

[7] ***Id.*** **at 6.**

[8] **The Commission itself said that it would continue to monitor developments in the band. See Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, First Report and Order, 17 FCC Rcd 7435, 7503 (¶ 196) (2002).**

radar systems the Commission might consider allowing in the band, such as frequency-hopping systems.

Future improvements to on-board sensor instruments are expected to result in greater sensitivity to the phenomena being monitored and, as a result, to interference. The NPOESS space segment will initially consist of two satellites in different polar orbital planes. In its final configuration, the space segment will be comprised of three satellites, each in different polar orbital planes. Up to six satellites will be deployed over the life of the system, through 2018.

Later satellites will carry next-generation sensors that will be expected to operate with greater sensitivities, requiring unlicensed devices to be subject to strict emissions limits and measurement methods.[9] Accordingly, even if new types of vehicular radars, such as the pulsed frequency-hopping devices proposed by Siemens, operate consistent with existing limits, they would impose limitations on the improved sensitivity that can be incorporated in next generation instruments. Therefore, the Parties urge the Commission not to permit the operation of pulsed frequency-hopping vehicular radar systems in the 22-29 GHz band unless the rules are amended to mitigate the potential for increased interference that would likely result.

IV. THE COMMISSION SHOULD LIMIT THE DEPLOYMENT OF UWB VEHICULAR RADAR DEVICES

While the Parties expect that vehicle manufacturers will meet the 2010 standards set forth in Section 15.515(c), the potential that these UWB proximity sensing devices might be used in applications other than terrestrial transportation vehicles causes concern that uncontrolled interference might result. Because these devices are unlicensed, there is no effective way for the Commission to undo damage once it is done. Accordingly, the Parties urge the Commission to clarify its rules that vehicular radar systems be subject to the following restrictions. Specifically, the Parties urge the Commission to adopt regulations to limit the sale of UWB vehicular radar devices to automotive applications using OEM installed units and to qualified dealer retrofits to older vehicles where vehicle manufacturers can show that the required performance standards can be met. Under no circumstances should these devices be available for retail sale.

V. CONCLUSION

For the reasons set forth above, the Parties urge the Commission not to permit pulsed frequency-hopping vehicular radar systems in the 23.6-24.0 GHz band without adopting strict limits to reduce the potential for increased interference. The standards being proposed by manufacturers in this proceeding for such devices would not satisfactorily protect passive sensors that must operate in this band. The Commission should also clarify existing unlicensed vehicular radar systems regulations to limit the sale of UWB vehicular radar devices.

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[9] ***Id.*** **at 6.**

Respectfully submitted,

NORTHROP GRUMMAN CORPORATION

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